AMENDMENTS TO THE CLAIMS

The following listing of claims will replace all prior versions and listings of claims in the application.

LISTING OF CLAIMS

1. (currently amended) A droplet ejection apparatus comprising:

a plurality of droplet ejection heads, each of the droplet ejection heads including:

a diaphragm;

an actuator which displaces the diaphragm;

a cavity filled with a liquid, an internal pressure of the cavity being increased and decreased in response to displacement of the diaphragm; and

a nozzle communicated with the cavity, through which the liquid is ejected in the form of droplets in response to the increase and decrease of the internal pressure of the cavity;

a driving circuit which drives the actuator of each droplet ejection head;

a residual vibration detecting unit ~~for detecting~~ that detects a residual vibration of the diaphragm displaced by the actuator after the actuator has been driven by the driving circuit;

a pulse generating unit ~~for generating~~ that generates reference pulses;

a computation unit ~~for carrying out a computation for~~ that carries out a computation for the number of reference pulses generated by the pulse generating unit on the basis of the residual vibration of the diaphragm detected by the residual vibration detecting unit;

a time measuring unit ~~for measuring~~ that measures a lapsed time since the actuator has been driven by the driving circuit;

a head failure judging unit ~~for judging~~ that judges a head failure in the droplet ejection heads on the basis of the computation result of the computation unit and the lapsed time measured by the time measuring unit; and

a switching unit ~~for switching~~ a that switches connection of the actuator from the driving circuit to the residual vibration detecting unit after carrying out the droplet ejection operation by driving the actuator.

2. (cancelled)

3. (currently amended) The droplet ejection apparatus as claimed in claim 1, wherein the computation unit includes a timing generating unit ~~for generating~~ that generates predetermined timing on the basis of the residual vibration detected by the residual vibration detecting unit, a counter which counts the number of reference pulses generated by the pulse generating unit for a predetermined time period, and a holding unit which holds the count value of the counter at the timing generated by the timing generating unit.

4. (original) The droplet ejection apparatus as claimed in claim 3, wherein the counter subtracts the number of reference pulses generated for the predetermined time period from a predetermined reference value.

5. (currently amended) The droplet ejection apparatus as claimed in claim 4, further comprising a memory ~~for storing~~ that stores the predetermined reference value.

6. (currently amended) The droplet ejection apparatus as claimed in claim 4, further comprising a temperature sensor ~~for measuring~~ that measures ambient temperature of the plurality of droplet ejection heads.

7. (original) The droplet ejection apparatus as claimed in claim 6, wherein the predetermined reference value is corrected on the basis of the ambient temperature measured by the temperature sensor.

8. (original) The droplet ejection apparatus as claimed in claim 3, wherein the predetermined time period is a time period until the residual vibration is generated after driving the actuator.

9. (original) The droplet ejection apparatus as claimed in claim 3, wherein the predetermined time period is a time period corresponding to a first half cycle of the residual vibration.

10. (original) The droplet ejection apparatus as claimed in claim 3, wherein the predetermined time period is a time period corresponding to a first one cycle of the residual vibration.

11. (previously presented) The droplet ejection apparatus as claimed in claim 1, wherein the head failure judging unit judges presence or absence of the head failure in the droplet ejection heads and a cause thereof on the basis of the computation result by the computation unit and the lapsed time.

12. (previously presented) The droplet ejection apparatus as claimed in claim 3, wherein the head failure judging unit judges a cause of the head failure on the basis of the count value held by the holding unit and the lapsed time.

13. (previously presented) The droplet ejection apparatus as claimed in claim 12, wherein the head failure judging unit judges that an air bubble has been intruded into the cavity as the cause of the head failure in the case where the held count value is larger than a first count threshold.

14. (previously presented) The droplet ejection apparatus as claimed in claim 12, wherein the head failure judging unit judges the cause of the head failure according to the lapsed time in the case where the held count value is smaller than a first count threshold.

15. (previously presented) The droplet ejection apparatus as claimed in claim 14, wherein the head failure judging unit judges that much paper dust is adhering in the vicinity of the outlet of the nozzle as the cause of the head failure in the case where the

held count value is smaller than a third count threshold and the lapsed time is smaller than a first time threshold.

16. (previously presented) The droplet ejection apparatus as claimed in claim 14, wherein the head failure judging unit judges that little paper dust is adhering in the vicinity of the outlet of the nozzle as the cause of the head failure in the case where the held count value is in the range between a second count threshold and a third count threshold and the lapsed time is smaller than a first time threshold.

17. (previously presented) The droplet ejection apparatus as claimed in claim 14, wherein the head failure judging unit judges that the head failure does not occur in the case where the held count value is in the range between the first count threshold and a second count threshold and the lapsed time is smaller than a first time threshold.

18. (previously presented) The droplet ejection apparatus as claimed in claim 14, wherein the head failure judging unit judges that much paper dust is adhering in the vicinity of the outlet of the nozzle as the cause of the head failure in the case where the held count value is smaller than a third count threshold and the lapsed time is in the range between first and second time thresholds.

19. (previously presented) The droplet ejection apparatus as claimed in claim 14, wherein the head failure judging unit judges that the liquid in the vicinity of the nozzle has somewhat thickened due to drying as the cause of the head failure in the

case where the held count value is in the range between a second count threshold and a third count threshold and the lapsed time is in the range between first and second time thresholds.

20. (previously presented) The droplet ejection apparatus as claimed in claim 14, wherein the head failure judging unit judges that the head failure does not occur in the case where the held count value is in the range between the first count threshold and a second count threshold and the lapsed time is in the range between first and second time thresholds.

21. (previously presented) The droplet ejection apparatus as claimed in claim 14, wherein the head failure judging unit judges that the liquid in the vicinity of the nozzle has considerably thickened due to drying as the cause of the head failure in the case where the held count value is smaller than a third count threshold and the lapsed time is larger than a second time threshold.

22. (previously presented) The droplet ejection apparatus as claimed in claim 14, wherein the head failure judging unit judges that little paper dust is adhering in the vicinity of the outlet of the nozzle as the cause of the head failure in the case where the held count value is in the range between a second count threshold and a third count threshold and the lapsed time is larger than a second time threshold.

23. (previously presented) The droplet ejection apparatus as claimed in claim 14, wherein the head failure judging unit judges that the head failure does not occur in the case where the held count value is in the range between the first count threshold and a second count threshold and the lapsed time is larger than a second time threshold.

24. (currently amended) The droplet ejection apparatus as claimed in claim 11, further comprising a recovery unit ~~for carrying out recovery processing~~ that carries out recovery processing to eliminate the cause of the head failure judged by the head failure judging unit.

25. (currently amended) The droplet ejection apparatus as claimed in claim 24, wherein the recovery unit includes: a wiping unit ~~for carrying out a~~ that carries out a wiping process in which a nozzle surface of the plurality of droplet ejection heads where the nozzles are arranged is wiped with a wiper; a flushing unit ~~for carrying out~~ that carries out a flushing process by which the droplets are preliminarily ejected through the predetermined nozzle by driving the actuator; and a pumping unit ~~for carrying out~~ that carries out a pump-suction process with the use of a pump connected to a cap that covers the nozzle surface of the plurality of droplet ejection heads.

26. (previously presented) The droplet ejection apparatus as claimed in claim 25, wherein the recovery unit carries out the flushing process or the pump-suction

process in the case where it is judged that the cause of the head failure is the little thickening of the liquid due to drying.

27. (previously presented) The droplet ejection apparatus as claimed in claim 25, wherein the recovery unit carries out the pump-suction process in the case where it is judged that the cause of the head failure is the considerable thickening of the liquid due to drying.

28. (previously presented) The droplet ejection apparatus as claimed in claim 25, wherein the recovery unit changes the number of ejections in the flushing process or a suction time of the pump in the pump-suction process according to the degree of the thickening of the liquid due to drying and carries out the flushing process or the pump-suction process in the case where it is judged that the cause of the head failure is the thickening of the liquid due to drying.

29. (previously presented) The droplet ejection apparatus as claimed in claim 25, wherein the recovery unit carries out the wiping process in the case where it is judged that the cause of the head failure is the adhesion of paper dust.

30. (previously presented) The droplet ejection apparatus as claimed in claim 25, wherein the recovery unit changes the number of wiping operations in the wiping process according to the degree of the adhesion of paper dust and carries out the

wiping process in the case where it is judged that the cause of the head failure is the adhesion of paper dust.

31. (previously presented) The droplet ejection apparatus as claimed in claim 25, wherein the recovery unit changes the number of wiping operations in the wiping process according to the degree of the ejection operations in the flushing process in response to the lapsed time and carries out the flushing process in the case where it is judged that the cause of the head failure is the little thickening of the liquid due to drying when the flushing process is to be carried out.

32. (previously presented) The droplet ejection apparatus as claimed in claim 25, wherein the recovery unit carries out the pump-suction process in the case where the cause of the head failure is the intrusion of air bubble.

33. (previously presented) The droplet ejection apparatus as claimed in claim 25, wherein the recovery unit changes a suction time of the pump in the pump-suction process according to the computation result and carries out the pump-suction process in the case where it is judged that the cause of the head failure is the intrusion of air bubble.

34. (previously presented) The droplet ejection apparatus as claimed in claim 24, wherein the recovery unit carries out the recovery processing until the cause of the head failure judged by the head failure judging unit is eliminated.

35. (currently amended) The droplet ejection apparatus as claimed in claim 24, further comprising:

an informing unit ~~for informing~~ that informs that the head failure is not recovered in the case where the cause of the head failure is not eliminated even though the recovery unit carried out the recovery processing.

36. (currently amended) The droplet ejection apparatus as claimed in claim 35, further comprising:

a liquid storage unit ~~for storing~~ that stores the liquid to be supplied to the cavities of the plurality of droplet ejection heads, wherein the informing unit informs that the liquid storage unit is to be exchanged in the case where the cause of the head failure is not eliminated even though the recovery unit carried out the recovery processing.

37. (previously presented) The droplet ejection apparatus as claimed in claim 24, wherein the droplet ejection apparatus is constructed so as to stop a printing operation when carrying out a printing operation in the case where the cause of the head failure is not eliminated even though the recovery unit carried out the recovery processing.

38. (currently amended) The droplet ejection apparatus as claimed in claim 1, further comprising a storage unit ~~for storing~~ that stores the judgment result judged by

the head failure judging means unit in association with the nozzle for which the judgment was carried out.

39. (cancelled).

40. (previously presented) The droplet ejection apparatus as claimed in claim 1, wherein the droplet ejection apparatus comprises a plurality of residual vibration detecting units, a plurality of computation units, a plurality of head failure judging units and a plurality of switching units;

wherein the switching units corresponding to the droplet ejection head in which the actuator has carried out the driving operation switches the connection of the actuator from the driving circuit to the corresponding residual vibration detecting unit, and then the head failure judging unit corresponding to the switched residual vibration detecting unit judges the head failure of the corresponding droplet ejection head.

41. (previously presented) The droplet ejection apparatus as claimed in claim 1, further comprising:

a plurality of switching units which respectively correspond to the plurality of droplet ejection heads; and

a detection determining unit that determines for which droplet ejection head the residual vibration detecting unit detects the residual vibration;

wherein the corresponding switching unit switches a connection of the actuator from the driving circuit to the residual vibration detecting unit after carrying out the

driving operation of the actuator of the droplet ejection head determined by the detection determining unit.

42. (previously presented) The droplet ejection apparatus as claimed in claim 1, wherein the residual vibration detecting unit includes an oscillation circuit and the oscillation circuit oscillates in response to an electric capacitance component of the actuator that varies with the residual vibration of the diaphragm or in response to an electromotive voltage component of the actuator.

43. (previously presented) The droplet ejection apparatus as claimed in claim 42, wherein the ejection failure detecting unit includes a resistor element connected to the actuator, and the oscillation circuit forms a CR oscillation circuit based on the electric capacitance component of the actuator and a resistance component of the resistor element.

44. (previously presented) The droplet ejection apparatus as claimed in claim 42, wherein the ejection failure detecting unit includes an F/V converting circuit that generates a voltage waveform in response to the residual vibration of the diaphragm from a predetermined group of signals generated based on changes in an oscillation frequency of an output signal from the oscillation circuit.

45. (previously presented) The droplet ejection apparatus as claimed in claim 44, wherein the ejection failure detecting unit includes a waveform shaping circuit that

shapes the voltage waveform in response to the residual vibration of the diaphragm generated by the F/V converting circuit into a predetermined waveform.

46. (currently amended) The droplet ejection apparatus as claimed in claim 45, wherein the waveform shaping circuit includes: a DC component eliminating unit ~~for eliminating~~ that eliminates a direct current component from the voltage waveform of the residual vibration of the diaphragm generated by the F/V converting circuit; and a comparator that compares the voltage waveform from which the direct current component thereof has been eliminated by the DC component eliminating unit with a predetermined voltage value;

wherein the comparator generates and outputs a rectangular wave based on this voltage comparison.

47. (original) The droplet ejection apparatus as claimed in claim 1, wherein the actuator includes an electrostatic actuator.

48. (previously presented) The droplet ejection apparatus as claimed in claim 1, wherein the actuator includes a piezoelectric actuator having a piezoelectric element and using a piezoelectric effect of the piezoelectric element.

49. (previously presented) The droplet ejection apparatus as claimed in claim 1, wherein the droplet ejection apparatus includes an ink jet printer.

50. – 61. (cancelled)